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INTERNATIONAL TRADE, INTERPROVINCIAL TRADE, AND CANADIAN PROVINCIAL GROWTH

By Serge Coulombe,
University of Ottawa

Working Paper Number 40
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ABSTRACT

This paper provides an empirical analysis of the comparative evolution of interprovincial and international trade and their effects on regional growth for the Canadian provinces since 1981. First, we establish a striking empirical fact: the 'L' curve that characterized the comparative evolution of interprovincial and international trade shares to gross domestic product (GDP) between 1981 and 2000. In the 1980s, the interprovincial trade share was falling while the international trade share was constant. A sharp break occurred around 1991 and, throughout the 1990s, the international trade share expanded rapidly while the interprovincial trade share remained constant. The analysis casts doubt on the pure diversion model often used in trade modelling, as in the structural gravity model of Anderson and van Wincoop (2003) used recently to revisit the Canada-U.S. border effect. In the second part of the paper, we use a conditional convergence-growth model to estimate the respective long-run effects of interprovincial trade and international trade on Canadian regional economies. It appears that international trade creates jobs and generates higher productivity. In contrast, interprovincial trade only creates jobs. In the long run, a 10 percent increase in international trade share translates into an increase in relative GDP per capita and in labour productivity of 6.3 and 4.0 percent, respectively. The long-run effect of a 10 percent increase in interprovincial trade on per capita GDP is 5.1 percent, but the effect on labour productivity is virtually nil.

1. INTRODUCTION

The Canadian economy has gone through a process of profound structural changes in the 1990s. From a macroeconomic perspective, the decade started with inflation pressures, a deep recession, an overvalued Canadian dollar, and a rising public debt. On the eve of the new millennium, the federal government and most provincial governments were generating budget surpluses; the battle (and maybe the war) against inflation was secured; and the economy, which had gone through a long period of steady economic growth, was apparently approaching the business cycle slowdown in a more favourable position than that of our southern neighbour.

The changes of the 1990s were related not only to macroeconomic fundamentals. As will be documented and analyzed in this paper, the orientation of regional trade links in Canada underwent a major shift around 1991. North-south trade with the United States started to boom and grew at a much faster pace than the traditional east-west trade flow.

As is the case of many countries confronted with globalization, the spectacular development of international trade links has raised a number of concerns among the Canadian public. It has brought some important issues regarding the effects of increased international trade on employment, standards of living, and welfare to the forefront of the economic policy scene. For opponents of globalization, international trade is often perceived in Canada as a substitute for traditional east-west pan-Canadian trade, as well as a threat to the Canadian way of life and to the economic and political independence of the country. The analysis presented in this paper addresses directly some of those policy issues.

The paper investigates the relationships between the economic growth of Canadian provinces and the change in the orientation of trade—north-south or international trade *vs* east-west or interprovincial trade—that occurred in the 1990s. The approach is essentially empirical and focuses on the 1981–2000 period in order to isolate long-run trends. The goal of our empirical analysis is twofold: to analyze the relationship between the two regional trade channels (north-south *vs* east-west); and to estimate the long-run effects of increased economic integration at the regional level on regional standards of living (GDP per capita), labour productivity, and employment, within a convergence-growth framework.

The period under study is rich in innovations as regards the comparative dynamic evolution of the inter-regional and international institutional contexts. It was first characterized by a sharp increase in international trade worldwide, especially in the 1990s, following the dismembering of the former USSR and the opening of the Chinese economy. The decrease in international trade barriers for Canada was accentuated in 1989 by the Canada-U.S. Free Trade Agreement (FTA). The existence of interprovincial trade barriers, and the frequent and spontaneous erection of new barriers, have long been recognized as a serious problem within the Canadian federation. From an institutional point of view, no progress was observed in trying to remove interprovincial barriers until 1995 with the conclusion of the Agreement on Internal Trade (AIT).[1] However, Knox's (2001) analysis casts doubt about the real effectiveness of the AIT. Consequently, the 1990s have seen a sharp relative decline in international relative to interprovincial trade barriers.

The paper makes an original contribution to research from two different perspectives. First, we combine in our empirical analysis two types of information to assess the empirical relationships between Canadian trade patterns. The first type of information is provided by time-series evidence, which is useful in revealing an important structural shock that occurred around 1991 in provincial trade patterns. The analysis offers a new perspective on the effect of the Canada-U.S. Free Trade Agreement on the relationship between interprovincial and international trade in Canada. The relative decline of the contribution of Canadian interprovincial trade to GDP is a phenomenon that preceded the expansion of

north-south international trade between Canada and the United States. The contribution of interprovincial trade in goods and services to GDP decreased steadily and significantly throughout the 1981–91 period, whereas the contribution of Canadian international trade to GDP was roughly steady. A significant structural break in the relationship between interprovincial and international trade occurred in 1991–92. Since 1991, Canadian international trade has boomed and the value of interprovincial trade has started to grow at the same long-run rate as the GDP. Theses facts are collected in a single scatter diagram highlighted as the 'L' curve in Section 2. The second type of information used in the empirical analysis is contained in the cross-sectional (across Canadian provinces) variance of trade data. The changes in trade patterns were not spread evenly across Canadian provinces. We maximize the use of this cross-sectional information in a pooled time-series cross-sectional framework that is first employed in Section 3 to test the relationship between interprovincial trade and international trade. The results indicate that the diversion hypothesis—used, for example, as the underlying framework in the structural gravity model of trade by Anderson and van Wincoop (2003)—is clearly rejected by the facts.

The paper also contributes to the voluminous literature on trade and growth—one of the oldest research topic in economics. In recent years, with the development of an international cross-country data bank, a vast literature has focused on the empirical relationship between economic growth and openness to trade.[2] To our knowledge, it is the first time that a paper analyzes the relationship between intra-national trade and international trade, and their connection to regional growth, using official, real comparable data. One of the key conclusions of Section 4 is that the two trade patterns—east-west interprovincial trade and north-south international trade in the Canadian case—do not produce the same results on regional relative economic performances. The underlying theoretical framework for the empirical analysis is the well-known conditional-convergence model of neoclassical growth (Mankiw, Romer and Weil, 1992). The conditional-convergence framework has been used recently by Vamvakidis (2002) to estimate the effect of openness on economic growth at the cross-country level. The empirical methodology to test for the growth-openness relationship in this study follows the conditional-convergence approach used by Coulombe (2000, 2003) to study long-run disparities among Canadian provinces. We find that international openness has a positive and significant effect on regional GDP per capita, productivity and employment. The quantitative effect measured by combining time-series and cross-sectional information in the Canadian regional data set is comparable to the elasticity estimated recently for a wide cross-section of countries by Frankel and Romer (1999) using a completely different methodology. The long-run regional effect of interprovincial trade is positive on GDP per capita and employment, but it is null on labour productivity.

Section 5 provides a broad policy discussion of some of the issues raised in the paper.

2. COMPARATIVE EVOLUTION OF INTERNATIONAL AND INTERPROVINCIAL TRADE

The 'L' curve is established as a striking empirical fact in the first sub-section. We explore further the relationship between intra-national and international trade in the following sub-sections with a decomposition by province and a disaggregation between goods and services.

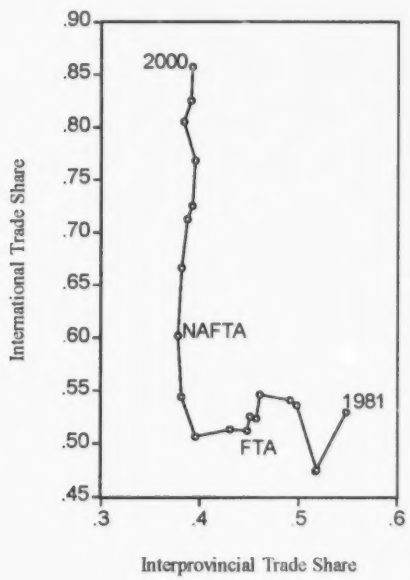
The 'L' Curve

Our two measures of international and interprovincial openness (*INOP* and *IPOP*, respectively) are the trade shares over GDP:

INOP = (international imports + international exports) / GDP
IPOP = (interprovincial imports + interprovincial exports) / GDP.

The data are available from Statistics Canada on an annual time-series basis for the ten Canadian provinces over the 1981–2000 period.[3] The idiosyncratic relative evolution of the two time series for Canada as a whole is best illustrated by the following scatter diagram (Figure 1) linking interprovincial and international trade shares.

Figure 1
The 'L' Curve



The scatter observations are linked by a line to illustrate the evolution over time.[4] The historical evolution starts at the south-east of the diagram and ends at the north-west. The evolution of the two trade shares in the scatter clearly exemplifies two distinct periods: (1) between 1981 and 1991, the share of interprovincial trade to GDP falls continuously and (relatively) steadily while the share of international trade to GDP is roughly constant; (2) between 1992 and 2000, the share of interprovincial trade to GDP is roughly constant while the share of international trade to GDP increases continuously and steadily. Obviously, the relationship between the two trade share variables appears to have been disrupted around 1991–92 by an important structural break.

We call this stylized fact the 'L' curve to describe the L shape of the scatter. We will describe it more thoroughly in the following sections by disaggregating trade flows by province and sector.

Disaggregation by Province

The scatter relationships between the trade share variables for the ten provinces are displayed in Figures 2, 3 and 4.

The typical L shape that characterizes the aggregate relationship between interprovincial and international openness appears to be driven by the two large central provinces, Quebec and Ontario. In these two core provinces, trade patterns evolve similarly and follow the Canadian pattern. The comparative evolution of trade links proceeds differently at the periphery.

At the beginning of the period under study, the four Atlantic provinces are the most dependent on interprovincial trade. In this region, both international and interprovincial trade shares decreased substantially during the 1981–91 period. Thereafter, the international trade share expands and the interprovincial trade share grows roughly at the same rate as GDP. Interestingly, most of the decrease in Atlantic Canada's openness to the rest of the country and to the rest of the world coincides with the severe 1981–83 recession. The drop in the share of international trade to GDP during this episode is particularly substantial for Newfoundland, Nova Scotia and New Brunswick.

There are few common patterns in the evolution of trade links across the four Western provinces. Saskatchewan and British Columbia are the only two Canadian provinces that did not experience a noticeable decrease in interprovincial trade share during the 1981–90 period. After 1992 for Manitoba, and 1993 for Saskatchewan and British Columbia, both the international and the interprovincial trade shares increased. Over the whole period, the decrease in interprovincial trade shares was not substantial in these three provinces.

The overall picture is different for Alberta. The major oil-producing province is the only one for which the scatter diagram suggests a negative relationship between the evolution of international and interprovincial trade shares. In fact, Alberta is the only province for which the two trade shares—*INOP* and *IPOP*—are negatively correlated (-0.11) in first differences over the entire period. For the other provinces, correlations are positive and vary from 0.20 for Ontario to 0.61 and 0.72 for Quebec and Newfoundland, respectively. Coupled with the graphical analysis of the scatter, this key information illustrates clearly that the trade diversion hypothesis (the increase in international trade could have diverted interprovincial trade) may be valuable only for Alberta. We come back to this point below.

Figure 2
Trade of Goods and Services – Atlantic

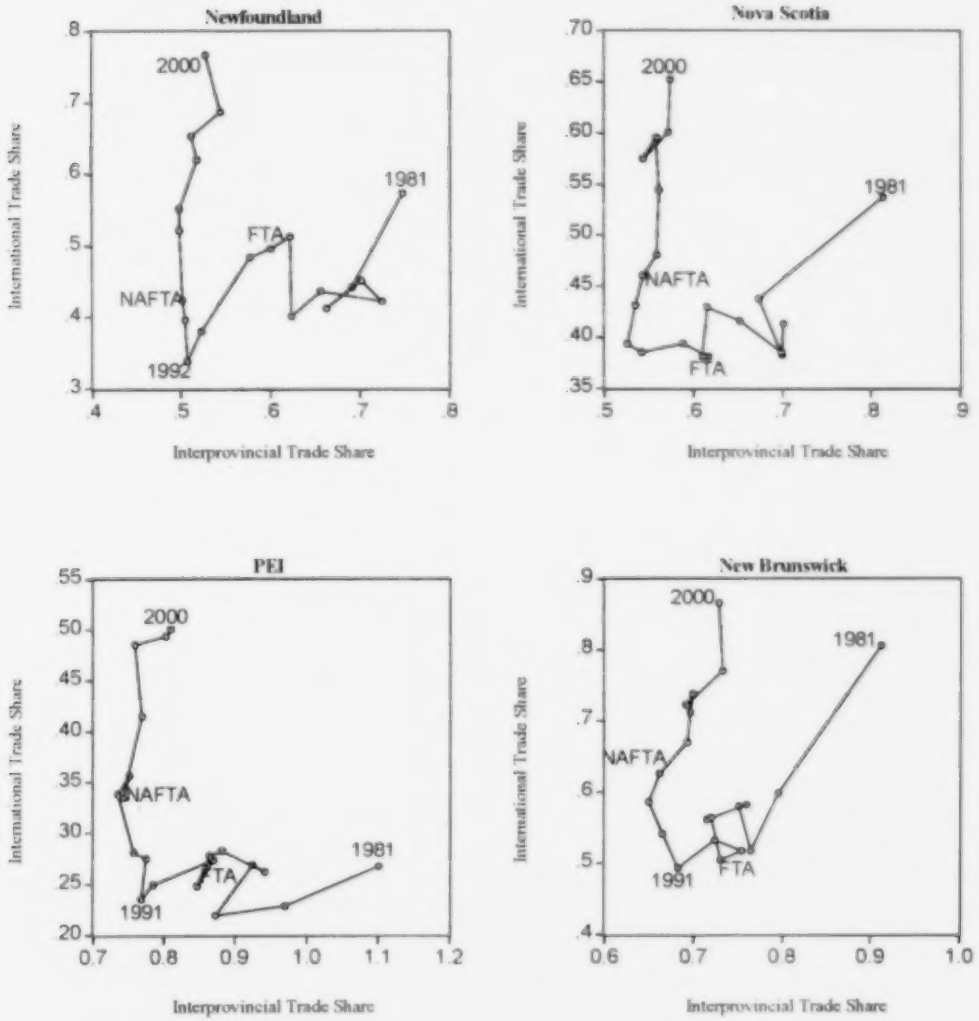
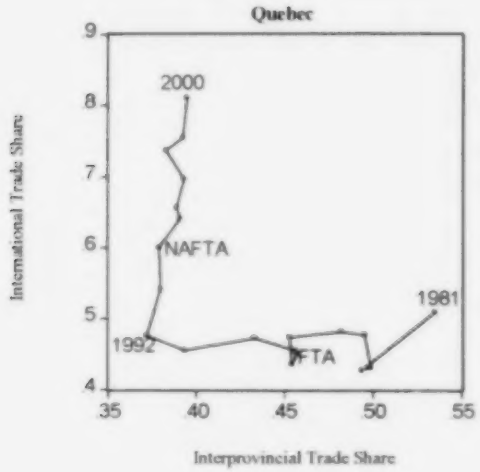


Figure 3
Trade of Goods and Services – Central Canada



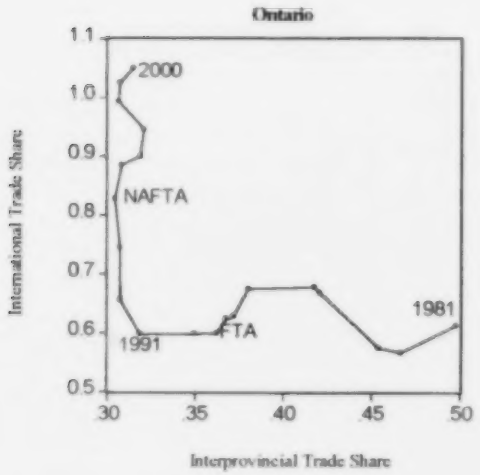
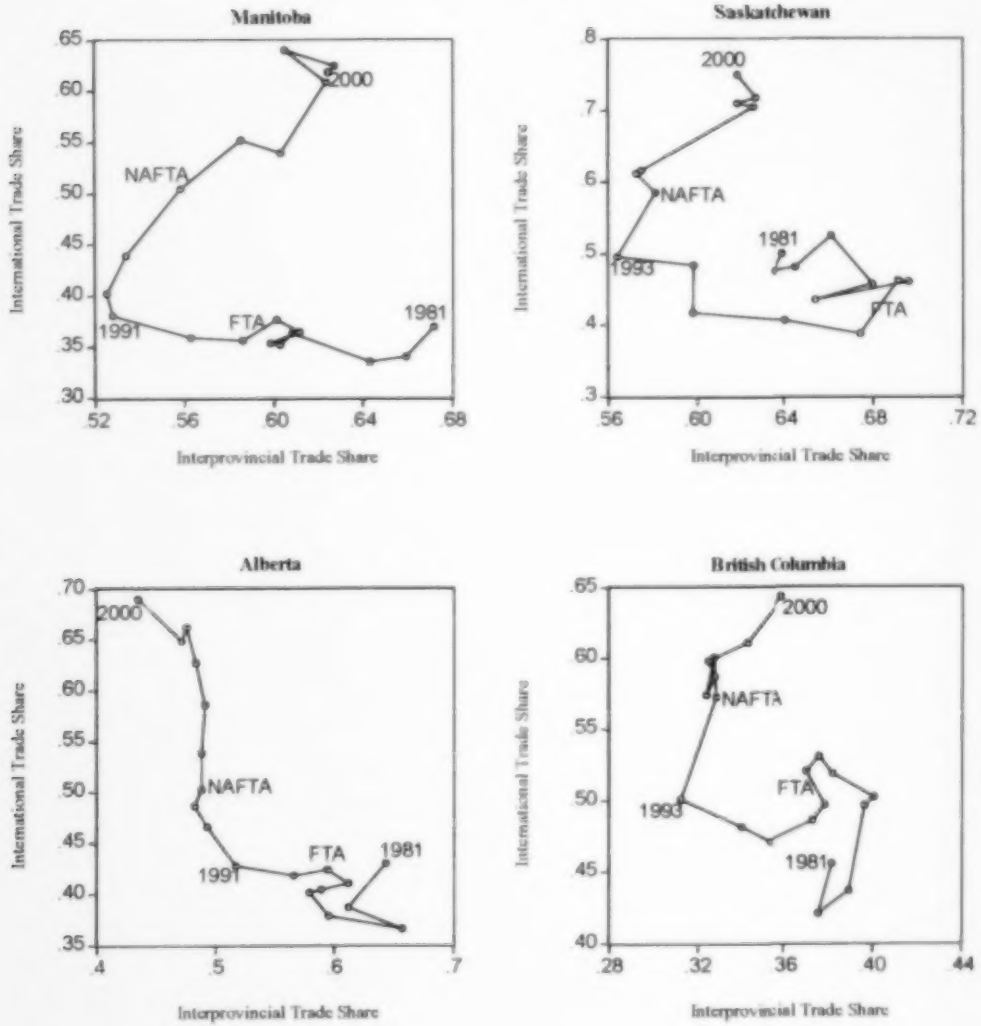


Figure 4
Trade of Goods and Services – Western Canada

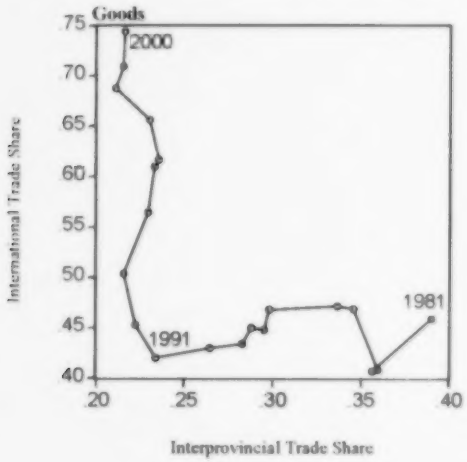


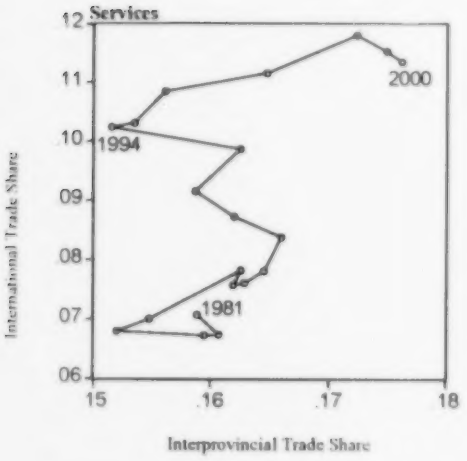
Services *vs* Goods

Some insights into the 'L' curve effect can be gained by disaggregating trade by the services and goods sectors. We computed the same trade share indexes for Canada for goods and for services by dividing exports plus imports of goods (or services) by GDP. The results are displayed in Figure 5.

The comparative evolution of international and interprovincial trade share indicators differs strikingly for goods and services. The relationship between international and interprovincial trade shares for goods follows the same 'L' curve shape as for total trade, i.e., the interprovincial trade ratio decreased in the 1981–91 period while the international trade ratio remained relatively stable; thereafter, interprovincial trade grew at roughly the same rate as GDP while international trade was booming.

Figure 5
Goods vs Services – Canada





The scatter for trade in services is completely different. Overall, both international and interprovincial trade in services tended to grow at a faster rate than GDP for the whole period. However, the expansion of interprovincial trade in services occurred during the 1994–2000 period, while the expansion of international trade in services is observed mainly over the 1981–94 period.

Figure 6 highlights another interesting stylized fact that raises many questions. Over the whole 1981–2000 period, international trade in services remained a very small and stable fraction of international trade in goods. Thus, one surely does not lose much information by focussing only on goods when analyzing the evolution of international trade in Canada. However, the picture is very different for interprovincial trade. Trade in services is a substantial fraction of goods trade and the share of services trade rose substantially during the period. Compared with international trade, interprovincial trade in services is much more intensive and the difference is growing with time.

Figure 6
Ratio of Trade in Services over Trade in Goods – Canada

The explanation of this stylized fact goes well beyond the scope of the paper, but the simple analysis presented in this section is useful. The 'L' curve phenomenon applies only to trade in goods, not to trade in services. Adding information from trade in services to analyze Canadian international trade patterns would not be the basis for a major hypothesis. However, this is not the case for interprovincial trade where trade in services plays a major and growing role.

3. THE 'L' CURVE AND THE DIVERSION HYPOTHESIS

Border Effect, the FTA and the Diversion Hypothesis

The 'L' curve raises many questions regarding the economics of Canadian trade patterns. Why was the interprovincial trade share falling during the 1980s? Why was interprovincial trade constant in the 1990s while international trade was rising? Why did a sharp break in trade patterns occur in the early 1990s? What was the role of the FTA in shaping the 'L' curve? Answering all these questions requires the use of detailed sectoral data and the econometric testing of alternative structural models of trade. Of course, this task goes well beyond the scope of our paper. In this section, we focus on a single important economic issue that appears to be in conflict with the most straightforward message that comes out of the L-shape curve: the diversion hypothesis. The diversion hypothesis implies that intra-national trade is a substitute for international trade. If, for example, interprovincial trade was artificially stimulated by Canada's tariff structure, with trade diversion, removing tariffs would generate an increase in international trade at the expense of a decrease in interprovincial trade.

The diversion hypothesis plays an important role in recent economic analysis of Canadian trade patterns. Pure trade diversion (one for one) between interprovincial trade and province-state trade is the underlying framework of the structural gravity model of trade recently used by Anderson and van Wincoop (2003) to revisit the Canada-U.S. border effect literature. Anderson and van Wincoop's model is based on the theoretical gravity model of trade first developed by Anderson (1979). One of the key modelling elements is the assumption that each regional economy is endowed with a fixed supply of a differentiated good. The good is either traded intra-nationally or internationally. The effect of trade barriers is to divert international trade toward the national market.

Anderson and van Wincoop (2003) demonstrate in this framework that standard McCallum-type border effect estimates are non-symmetrical. McCallum (1995) measured the effect of trade barriers on Canada-U.S. regional trade patterns using a gravity model of trade. The border effect was measured as the ratio of interprovincial trade to province-state weighted (by size and distance) trade. He found that, typically, trade between two Canadian provinces was (in 1988) 22 times larger than trade between a Canadian province and a U.S. state. This finding was recognized by Obstfeld and Rogoff (2000) as one of the trade puzzles and the issue was carefully analyzed and documented in a series of papers by John Helliwell.[5] In this section, by pooling the time-series and cross-section information contained in the evolution of provincial trade patterns since 1980, we show that the underlying pure trade diversion theoretical framework of Anderson and van Wincoop (2003) is clearly rejected by Canadian facts. This point is important for the border effect literature since Canadian data bases on interprovincial trade and international trade have been, from the start, at the centre of border-effect studies using real intra-national trade data.

The diversion hypothesis is also an important element of the interpretation of the effects of the FTA on Canadian trade patterns. The FTA is the obvious institutional change that likely affected the orientation of provincial trade patterns in Canada. The FTA gradually eliminated or reduced tariffs and non-tariff trade barriers between Canada and the United States between January 1, 1989 and January 1, 1998. The Canada-U.S. Free Trade Agreement was extended to Mexico on January 1, 1994 with the adoption of the North American Free Trade Agreement (NAFTA). During this period, Canada experienced a spectacular increase in its trade with its southern neighbour. The decrease in the relative importance of interprovincial trade over the 1988–96 period has been documented and analyzed in Helliwell, Lee and Messinger (1999). Based on evidence from industry-level data on commodity trade and tariffs, these authors conclude that part of the relative decline in interprovincial trade might be

attributed to the FTA. We will show in this section that the underlying time-series and cross-sectional information contained in Canadian provinces data casts doubt on this interpretation of the effect of the FTA.

Empirical testing of trade diversion *vs* trade creation following changes in trade barriers is a long-standing topic of study in economics (Balassa, 1967). Trade diversion might be the result of a variety of trade models. The empirical analysis produced in this section is not based on a structural model of trade. Instead of focussing on a structural model of trade or a family of models, we proceed with a theoretical approach by directly testing the prediction of trade diversion using the information contained in the pooling of time-series and cross-section data on the shares of interprovincial and international trade for the ten Canadian provinces in the 1981-2000 sample.

On a time-series basis, for one single province, trade diversion implies that an increase in international trade share is matched by a decrease in interprovincial trade share. We test for a contemporaneous relationship between the two trade variables and examine the possibility of a Granger causality between the two. From a cross-sectional point of view, the diversion hypothesis implies that provinces with a higher international trade share have a lower interprovincial trade share. This is a key prediction of the endowment economy of Anderson and van Wincoop (2003), in which international trade is a substitute (one for one) for intra-national trade. We pool both types of information in an empirical setting where appropriate measures are gradually taken into account to tackle various econometric problems encountered in this type of analysis: various forms of heteroscedasticity, fixed effects, structural break, and autocorrelation.

Empirical Investigation on the Theme of Trade Diversion

The analysis is carried out in two steps. First, we combine the pooled time-series and cross-sectional (across provinces) information for the ten Canadian provinces in the 1981–2000 sample to analyze the contemporaneous relationship between international and interprovincial trade shares. Second, we apply a Granger causality test to these two variables to determine if there is a causal relationship between them.

The results of five diversion regressions are displayed in Table 1. In the first two regressions, the hypothesis is tested on the levels of the *IPOP* and *INOP* variables. In the last three regressions, the hypothesis is tested on the first differences: *d(IPOP)* and *d(INOP)*. Interprovincial trade shares are used as the dependent variable. The diversion hypothesis implies that the expansion of international trade has a negative and significant effect on interprovincial trade shares, on average, for the ten Canadian provinces. In all five regressions, we used fixed effects to model the fact that the Canadian provinces follow different trends in the evolution of interprovincial trade shares.

In the first three regressions, we estimated the system using a seemingly unrelated regression (SUR) framework, which is the least restricted framework here as it corrects for both contemporaneous correlation and cross-sectional heteroscedasticity. For the last two regressions done with sub-samples, it was not possible to use SUR due to the limited number of time-series observations. For these two sub-sample regressions, we used iterated feasible generalized least squares (IFGLS) to account for cross-sectional heteroscedasticity. They produced estimates consistent with the ones obtained with SUR for the first-difference set-up in the whole sample.

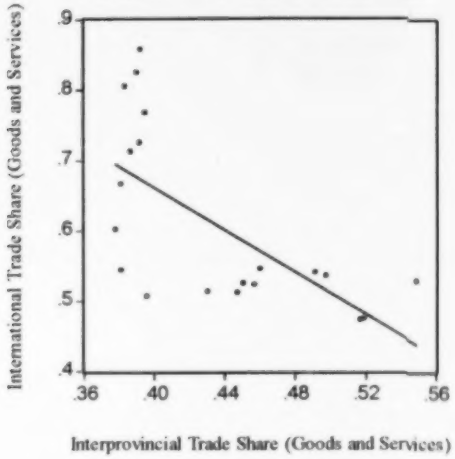
Table 1
Estimation Results for the Diversion Hypothesis

Dependent Variable SAMPLE ▶	*IPOP* 1981–2000 (1)	*IPOP* 1981–2000 (2)	*d(IPOP)* 1981–2000 (3)	*d(IPOP)* 1981–91 (4)	*d(IPOP)* 1991–2000 (5)
Estimation	**SUR**	**SUR**	**SUR**	**IFGLS**	**IFGLS**
INOP	-0.187*** (0.011)	0.052** (0.024)			
d(INOP)			0.223*** (0.027)	0.175*** (0.060)	0.264*** (0.050)
BR91		-0.036*** (0.008)			
AL-FE	0.63***	0.51***	-0.015**	-0.012	-0.020***
BC-FE	0.46***	0.35***	-0.003	-0.003**	-0.005*
MA-FE	0.68***	0.59***	-0.005	-0.015***	-0.001
NB-FE	0.84***	0.69***	-0.010*	-0.017*	-0.008
NF-FE	0.68***	0.55***	-0.014**	-0.019**	-0.012**
NS-FE	0.70***	0.57***	-0.014*	-0.024	-0.008
ON-FE	0.50***	0.31***	-0.015***	-0.018***	-0.016***
PE-FE	0.90***	0.80***	-0.018*	-0.033	-0.004
QU-FE	0.53***	0.40***	-0.011***	-0.013***	-0.013***
SA-FE	0.72***	0.62***	-0.004	-0.002	-0.011
AR-correction	NO	YES	NO	NO	NO
S.E. of regression	0.059	0.022	0.026	0.031	0.018
R-squared	0.87	0.98	0.21	0.16	0.26
Durbin-Watson	0.32	1.75	1.84	1.97	1.77
Panel observations	200	190	190	100	100

Notes: IFGLS are iterated feasible generalized (linear) least-square estimations using cross-section weighted regressions to account for cross-sectional heteroscedasticity.
***, ** and * indicate that the null hypothesis could be rejected at the 1 percent, 5 percent and 10 percent critical levels, respectively.
White heteroscedasticity-consistent standard error (HCCME) (between brackets for IFGLS regressions only) allows for asymptotically valid inferences in the presence of heteroscedasticity.
SUR is seemingly unrelated regression.
Adjusted sample 1982–99.
AR-correction is correction for autocorrelation. Except for the first regression, AR-correction was systematically performed and the AR coefficients were dropped when not significant.

In the first column, the diversion hypothesis is tested on levels following a straightforward approach that mimic a cross-section econometric approach by abstracting from time-series consideration. In this first econometric set-up, we ignore the important structural break that occurred around 1991 in the relationship between international and interprovincial trade shares, depicted by the 'L' curve, and we do not correct for autocorrelation. The effect of international trade on interprovincial trade shares is negative, substantial, and extremely significant (at the 1 percent level), and the regression has a high

Figure 7
The Negative Correlation Between Interprovincial and International Trade – Canada



R-squared of 0.87. This exercise illustrates the danger of testing the diversion hypothesis by comparing interprovincial and international trade between two dates (such as 1988 before the FTA, and 1996 after the FTA, as in Helliwell, Lee and Messinger, 1999) without taking into consideration the 1991 structural break. The negative correlation between the levels of international and interprovincial trade shares in periods that include the structural break suggests that the diversion hypothesis should not be rejected. The negative correlation between the two variables is illustrated in Figure 7 with a simple scatter between the two variables including the OLS regression.

Due to the time-series dimension of the actual analysis, an important warning stems from the results of the first regression. The very low Durbin-Watson statistic (0.32) is clear evidence of positive serial correlation in the residuals. The serial correlation is viewed in Figure 7 with systematic positive residuals at the beginning of the sample, followed by systematic negative residuals in the middle and by systematic negative residuals thereafter. As documented and explained in Granger and Newbold (1974) and Phillips (1983), the use of non-stationary data in econometrics might result in spurious regressions. A spurious regression will typically produce a very high R-squared and a very low Durbin-Watson. As a practical rule of thumb, a Durbin-Watson statistic that is lower than the R-squared is evidence of a spurious regression.

The next four regressions use two alternative approaches to tackle the econometric problems of the first diversion regression. In the second regression, we also estimate the diversion hypothesis with the levels of the *IPOP* and *INOP* variables. However, we explicitly model the structural break by introducing a time dummy (*BR91*) taking the value zero prior to 1991 and one thereafter for the ten provinces.[6] We also correct for serial correlation with a common (for all provinces) *AR(1)* in the regression. The result pertaining to the diversion hypothesis is reversed! International openness now has a positive and significant effect (at the 5 percent level) on interprovincial trade shares. The *BR91* structural break variable is negative and significant at the 1 percent level. The standard error of regression is much lower than in the first regression; the R-squared is 0.98 and the Durbin-Watson is close to 2. Obviously, regression (2) provides a much better fit than regression (1).

Two supplementary points are worth mentioning regarding the econometric results of regression (2). First, the negative value of the 1991 break variable does not imply that the FTA had a negative effect on interprovincial trade. The reason for the negative value is that the *INOP* variable grows faster after 1991 and the effect of *INOP* on interprovincial trade is positive. The total effect of the changing trade patterns after 1991 on interprovincial trade shares will be best viewed with the following three regressions on first differences. Second, the parameter estimates for the fixed effects are indicators of the relative interprovincial trade shares across Canadian provinces. It is interesting to note that the three provinces with a lower dependency on interprovincial openness are Ontario, British Columbia and Quebec. In Beine and Coulombe's study (2003), these three provinces show a business cycle that is more correlated with the U.S. business cycle.

In regressions (3), (4) and (5), we followed a straightforward approach to tackle the issue of non-stationarity by taking the first differences of both trade variables. In regression (3), the system was estimated for the entire 1981–2000 period. We repeated the same regression setting for the two sub-samples of 1981–91 and 1991–2000, which are divided by the date of the structural break in the relationship between the levels of the two trade variables.

For the three regressions using first differences, the diversion hypothesis is strongly rejected with a positive, substantial, and significant (at the 1 percent level) effect of the change in international trade shares on the change in interprovincial trade shares. Interestingly, the effect is stronger after 1991 than before. A 100 percent point increase in international trade induces a 17.5 percent and a 26.4 percent point increase in interprovincial trade before and after 1991, respectively.

In the first-difference set-up, fixed-effect parameters estimate long-run trends in annual growth of interprovincial trade shares, based on the assumption that there is no change in international trade shares. The point estimates are not all statistically different from zero. They are, however, all negative and some of them are highly significant. For Ontario and Quebec, the long-lasting decrease in interprovincial trade shares is significant at the 1 percent level. For Newfoundland, the decrease is significant at the 5 percent level. For Alberta, the decrease is significant at the 1 percent level over the 1991–2000 period only.

Having now established that there is a positive relationship between international and interprovincial trade in light of the 1981–2000 cross-sectional and time-series information, we attempt in the last empirical exercise of this section to verify if there are causality links between the two trade channels. The following Granger causality test has to be viewed with great caution of course, since the number of time-series observations at our disposal is very limited. We have to split the sample into two periods (1981–91 and 1991–2000) because Granger causality tests would suffer from a serious bias if performed over a period where a structural break in the relation between the two variables under study is observed. Given the limited number of time-series observations, we have to restrict our study to a one-year lag.

Results for the 1991–2000 period are presented in Table 2. Interestingly, the null hypothesis of non-Granger causality is rejected for both relationships (*INOP* causing *IPOP* and the reverse) for the aggregate trade data of both Canada and Quebec. Evidence is mixed for Ontario since the null hypothesis cannot be rejected for one relationship. Overall, the results suggest that there is some evidence of a simultaneous (and positive, given the results of regression (5) in Table 1) causality between international trade and interprovincial trade in Canada over the 1991–2000 sample period.[7]

Table 2
Pairwise Granger Causality Tests: Interprovincial and International Openness

Null Hypothesis	F-Statistic	P-Value
INOP (Canada) does not Granger cause *IPOP* (Canada)	6.80	0.035
IPOP (Canada) does not Granger cause *INOP* (Canada)	14.02	0.007
INOP (Quebec) does not Granger cause *IPOP* (Quebec)	7.08	0.032
IPOP (Quebec) does not Granger cause *INOP* (Quebec)	11.57	0.011
INOP (Ontario) does not Granger cause *IPOP* (Ontario)	1.30	0.292
IPOP (Ontario) does not Granger cause *INOP* (Ontario)	8.82	0.021

Discussion: The FTA

One insight revealed by the comparative analysis of the evolution of interprovincial and international trade links in this section is the fact that the structural shock that disrupted the relationship between the two trade channels did not coincide with the implementation of the FTA. This structural shock affected the data between 1991 and 1992, while the FTA came into effect on January 1, 1989. Between the end of 1988 and 1991-92, the relationship between interprovincial trade and international trade appears to continue to evolve along the general trend observed during the 1980s: a decrease in interprovincial trade coupled with an increase in international trade at a rate similar to the GDP.

It is interesting to note that the structural shock in the evolution of our trade links coincided with the start of a period of steady decline in the value of the Canadian dollar as measured by the bilateral exchange rate with the United States. The value of the Canadian dollar reached its peak in October 1991 but had lost 35 percent of its value against the U.S. dollar by January 2002.[8] It is usually understood that the Canadian dollar was overvalued in the 1988–91 period due to the restrictive monetary policy followed at the time. We cannot test directly with the framework used in this paper whether or not the exchange rate misalignment delayed the FTA effect on the expansion of Canada's international trade. However, this is a possible explanation that could account for the stylized facts reported in this section.

4. ESTIMATING THE LONG-RUN EFFECT OF INTERNATIONAL AND INTERPROVINCIAL TRADE ON PROVINCIAL GROWTH

As pointed out in Aghion and Howitt (1998, section 11.6), it is very difficult in modern growth theory to isolate the effect of expanding trade links on an economy's long-run income and welfare. Many different dynamic channels intervene, such as human and physical accumulation, factor price equalization, agglomeration effects and scale economies, and dynamic comparative advantage. For example, Ben-David and Loewy (1998) found that knowledge spillovers resulting from increased trade have a positive effect on economic growth during the transition process and in the long run. On empirical grounds, however, most modern research emphasizes the positive effect of increased international trade on economic growth. As Vamvakidis (2002) shows, this positive effect might be limited to recent decades (since 1970). Prior to this, he finds no support for a positive relationship between economic growth and trade measures over a cross-section of countries.[9]

In this section, we use cross-sectional information contained in the asymmetric evolution of provincial trade patterns to estimate the long-run effect of trade on provincial GDP per capita and labour productivity in a conditional-convergence framework. This framework works well for testing the relationship between openness and growth, as was done in Vamvakidis (2002).

Theoretical Foundations and Empirical Methodology

The underlying theoretical framework for the empirical analysis in this section is the conditional-convergence growth model of Mankiw, Romer, and Weil (1992) and of Barro and Sala-I-Martin (1995). In this framework, during the transition process toward the steady state, the evolution of the logarithm of per capita output or labour productivity $y_{i,t}$ in the regional economy i at time t (for $i = 1, ..., N$ and $t = 1, ..., T$) is a function of its initial level $y_{i,0}$ and its steady-state value y^*_i. This dynamic process can be written as

$$y_{i,t} = e^{-\beta} y_{i,t-1} + (1 - e^{-\beta}) y^*_i + \varepsilon_{i,t}. \quad (1)$$

In this equation, β is the annual speed of convergence toward the steady state and the additive error term $\varepsilon_{i,t}$ captures the effect of regional shocks that temporarily affect the economy i at time t. If β equals 0, $y_{i,t}$ is determined only by $y_{i,t-1}$; the economy does not converge to y^*_i; and $y_{i,t}$ is integrated of order one. However, the economy converges to a steady state y^*_i when β is positive and smaller than one. The conditional-convergence hypothesis refers to the case when the N economic units converge to different steady-state values for y^*_i.

The convergence equation was initially tested using the cross-section information only contained in cross-country or cross-state data bases (Barro, 1991; and Barro and Sala-I-Martin, 1992). The mean growth rate of y_i in the time interval 0-T was regressed on the initial level of $y_{i,0}$. However, this approach suffers from many drawbacks. Some economies might reach their steady state in the middle of the interval which implies that the speed of convergence would be seriously under-estimated. Structural shocks that affect the steady state of an economy during the time interval are wiped out of the information in a cross-sectional framework. It is now recognized that combining the time-series and the cross-sectional information has several advantages over the cross-section approach.[10] The pooling or panel data approach for testing the convergence equation maximizes the use of information since it takes into account the information contained in the time-series evolution of an economy toward its own steady state.

However, the pooling of time-series and cross-sectional information in a convergence-growth framework has to be done very carefully since the two types of information are not straightforwardly comparable.

For this reason, in equation (1) (following Coulombe and Lee, 1995)—and as will be the case for all variables used in the empirical analysis presented in this paper—the regional economic variable $x_{i,t}$ (like $y_{i,t}$ and y^*_i) is measured as the logarithmic deviation from the cross-sectional mean at time t:

$$x_{i,t} = \log\left(X_{i,t} \Big/ \sum_{i=1}^{N} \tfrac{1}{N} X_{i,t} \right),$$

where $X_{i,t}$ is the level of the logarithm $x_{i,t}$. In this setting, y^*_i is the relative long-run gap between province i and the unweighted provinces' mean value of economic indicator y. The use of variables measured by the deviation from their sample mean proved extremely useful in pooled time-series cross-sectional convergence regressions as it eliminates common factors, such as the productivity slowdown, that might bias the results.

In this paper, we follow the empirical methodology employed by Coulombe (2000, 2003) to test equation (1) using annual pooled time-series cross-sectional observations. Coulombe's analysis focuses on the relative evolution of pre- and post-transfer measures of per capita income across the ten Canadian provinces in the 1950–96 sample, where the relative rates of urbanization of the provinces are used as instruments for y^*_i. The results indicate that provinces have converged at a rate of around 5 percent per year toward their relative long-run steady state. Furthermore, most provinces appeared to be in the neighbourhood of their respective steady state since the mid-1980s. Coulombe (2000) also found significant structural shocks to the steady-state relative position of Alberta and Quebec in the early 1970s associated with the oil shock and the relative decline of Montreal. The convergence regression used by Coulombe (2000) is:

$$y_{i,t} = \gamma_1 y_{i,t-1} + \gamma_2 RU_i + \gamma_3 DA_{i,t} + \gamma_4 DQ_{i,t} + \varepsilon_{i,t}.$$

The convergence parameter γ_1 is equal to the $e^{-\beta}$ of equation (1) and the variables RU_i, $DA_{i,t}$, and $DQ_{i,t}$ —the relative urbanization variable, and the Alberta and Quebec dummies, respectively—determine the relative steady-state values y^*_i.

In this paper, we want to test the hypothesis that the developments observed in interprovincial and international trade links over the 1981–99[11] period might have affected key, long-run, relative provincial macroeconomic indicators such as GDP per capita and labour productivity. To this end, the methodology of Coulombe (2000) had to be adapted to the problem under study here, in three ways. First, the sample used in Coulombe (2000) had to be restricted to the 1981–99 period, given the availability of comparable trade data at the regional level. Second, the whole series on international and interprovincial trade had to be used in the empirical analysis since provincial trade patterns evolved asymmetrically during the period under study. Third, we ignored specific shocks to Quebec and Alberta since they occurred prior to the period studied.[12] The first two of these modifications to the previous methodology used by Coulombe (2000) are important methodological changes and are discussed here.

First, restricting the study period to 1981–99 translates into a massive loss of information compared to Coulombe's (2000) analysis. As shown in a number of studies published recently on convergence among Canadian provinces (e.g., Coulombe and Day, 1999; Coulombe, 2000; Coulombe and Tremblay, 2001), most of the evolution in the cross-sectional variance among Canadian provinces' per capita income and related indicators occurred in the 1950–80 period. During this period, the relative dispersion across provinces of per capita income and other related indicators show a tendency to decrease

over time, a phenomenon known as σ-convergence in economic growth. Since the early 1980s, the relative dispersion appears to be in the neighbourhood of its steady-state level. Consequently, the cross-sectional variance is much smaller in the 1981–99 sample than in the 1950–96 sample used in Coulombe (2000). A convergence regression tested for the 1981–99 sample would rely more on the information related to the time-series variance that came out with the evolution of the variables $y_{i,t}$ over time. It is important to bear this in mind when analyzing the results of the empirical analysis conducted in this paper. The results might differ from the ones found in Coulombe (2000), and the parameter estimations be less precise, since a great deal of information has been removed from the analysis due to the restrictions imposed on the period studied.

Second, we test if the evolution of relative interprovincial and international openness in the 1981–99 sample has affected the steady-state relative values of labour productivity and GDP per capita in the Canadian provinces. The convergence regression equation used to test this hypothesis for both relative GDP per capita and relative labour productivity is the following variation of equation (1):

$$y_{i,t} = \gamma_1 y_{i,t-1} + \gamma_2 RU_i + \gamma_3 INOP_{i,t-1} + \gamma_4 IPOP_{i,t-1} + \varepsilon_{i,t}. \quad (2)$$

As in Coulombe (2000), RU_i stands for the relative urbanization variable. It is a cross-sectional variable with just one observation per province. $INOP_{i,t-1}$ and $IPOP_{i,t-1}$ are the measures of international and interprovincial trade shares, respectively. $INOP_{i,t-1}$ and $IPOP_{i,t-1}$ are lagged one period in the convergence regression equation (2) to avoid the simultaneity problem that might occur if there were a mutual contemporaneous causality between these variables and the dependent variable. In this dynamic set-up, if γ_3 and γ_4 are statistically significant and γ_1 is smaller than one, shocks to $INOP_{i,t}$ and $IPOP_{i,t}$, which are measured as deviations from the cross-sectional mean, disturb the steady-state relative values of variable y.[13]

The Results

Convergence regression results for four specifications of equation (2) are displayed in Table 3. The results for the convergence regression of GDP per capita are depicted in columns (1) and (2), and the results for the convergence of productivity in columns (3) and (4). For the two cases, we present results when *INOP* and *IPOP* are measured from the real and the nominal GDP data base.[14] The conditional-convergence speeds were estimated using the first difference of $y_{i,t}$ as the dependent variable in equation (2). This does not change the estimation of the other parameters reported in Table 3. Convergence speeds are significant at the 1 percent critical level for GDP per capita, and at the 5 percent level for labour productivity. Interestingly, the conditional-convergence speeds vary between 4.9 and 5.9 percent—very close to the estimates of 5.0 and 5.1 percent obtained by Coulombe (2000) for per capita income and per capita income minus government transfers in the 1951–96 sample. However, the urbanization variable is significant (with the expected positive sign) only for specification (1). Long-run differences in per capita GDP and labour productivity are not captured by the relative urbanization variable in the other three specifications. It appears that the long-run effect of the urbanization variable is harder to estimate when the cross-sectional and time-series information associated with the σ-convergence of the 1950–80 period is not taken into account in the conditional-convergence regression.

Table 3
Estimation Results for per Capita GDP and Labour Productivity Convergence Regression (equation (2) with IFGLS)

Dependent Variable y ▶	GDP per Capita (1)	GDP per Capita (2)	Labour Productivity (3)	Labour Productivity (4)
$y(-1)$	0.941***	0.951***	0.942***	0.948***
	(0.016)	(0.017)	(0.027)	(0.026)
Convergence speed	0.059	0.049	0.058	0.052
(p value)	(0.0003)	(0.004)	(0.032)	(0.0500)
RU	0.036**	0.023	0.000	-0.001
	(0.020)	(0.020)	(0.007)	(0.008)
INOP (-1) (nominal)	0.037***		0.023***	
	(0.010)		(0.008)	
IPOP (-1) (nominal)	0.032***		0.001	
	(0.011)		(0.007)	
INOP (-1) (real)		0.025**		0.020**
		(0.001)		(0.008)
IPOP (-1) (real)		0.017*		0.001
		(0.001)		(0.006)
S.E. of regression	0.024	0.024	0.021	0.021
R-squared	0.987	0.984	0.959	0.959

Notes: IFGLS are iterated feasible generalized (linear) least-square estimations using cross-section weighted regressions to account for cross-sectional heteroscedasticity.
***, ** and * indicate that the null hypothesis could be rejected at the 1 percent, 5 percent and 10 percent critical levels, respectively.
White heteroscedasticity-consistent standard error (HCCME) (between brackets) allows for asymptotically valid inferences in the presence of heteroscedasticity.
Adjusted sample 1982–99; 180 panel observations.
AR-correction is correction for autocorrelation. AR-correction was systematically performed and the AR coefficients were dropped when not significant. No significant autocorrelation was found.
Estimations were done using EViews 4.0.

More importantly for the purpose of this paper, the analysis of the estimated coefficients for the international and interprovincial openness variables is revealing. The various estimated coefficients for the international openness variable are all positive and highly significant with p value below 0.013 in the four cases. For the interprovincial openness variable, however, the effect is significant (at the 1 percent and the 10 percent level) only for GDP per capita. The long-run estimated effect of interprovincial trade on labour productivity is virtually zero.

To complement this qualitative analysis, we present in Table 4 the long-run elasticities of per capita GDP and labour productivity to the different environmental variables. The estimated elasticity of the urbanization variable to long-run relative per capita GDP is 0.61 when the openness variables are captured by the nominal data set. This number is consistent with the estimated elasticities of the urbanization variable in Coulombe (2000) of 0.78 and 0.51 for per capita income minus transfers and per capita income, respectively.

Table 4
Long-run Elasticity of Environmental Variables

Dependent Variable *y* ▶	GDP per Capita	Labour Productivity
RU	0.61	–
INOP (nominal)	0.63	0.40
IPOP (nominal)	0.54	–
INOP (real)	0.51	0.38
IPOP (real)	0.35	–

Note: Computed from Table 3 using the long-run solution of equation (2).

Regarding the impact of trade openness on per capita GDP, the effect is larger for international openness than for interprovincial openness for both the nominal and the real measure of trade. However, the difference is not significant using Wald tests. Not surprisingly, the long-run effect is greater for the nominal than for the real measure, as the effect of terms-of-trade changes is included in the former and excluded in the latter. A 10 percent increase in trade shares, including the terms-of-trade effects, translates into an increase in per capita relative GDP of 6.3 percent and 5.4 percent for international trade and interprovincial trade, respectively. For the real measure of trade, the effect on per capita GDP is 5.1 percent and 3.5 percent for international trade and interprovincial trade, respectively. In this regional growth framework, increased relative (with respect to other provinces) trade openness in a province produces a higher standard of living in the long run as measured by per capita GDP. However, the effect of trade openness on labour productivity is more muted. The elasticities are smaller for international openness (roughly two-thirds of the effect observed on per capita GDP) and the effect is nil for interprovincial openness.

On quantitative grounds, the estimated elasticities for the international trade shares are consistent with the empirical estimates of Frankel and Romer (1999) using a cross-country data set and a geographic adjustment in the spirit of gravity models to correct for size and distance. These authors estimated that an increase of 10 percent in the share of trade to GDP generates an increase of at least 5 percent in income per capita. They also found a much smaller effect for within-country trade, with a real GDP per worker elasticity to domestic trade of around 0.1.

Furthermore, the comparative analysis of per capita GDP and labour productivity in this convergence growth framework might reveal some interesting insights regarding the relative evolution of regional employment, such as those found in Coulombe and Day (1999). The difference between the effect of trade openness (and the urbanization variable) on GDP per capita and labour productivity is explained by the evolution of provincial relative employment. Since the effect of interprovincial trade on labour productivity is nil, the results suggest that interprovincial trade increases long-run standard of living at the provincial level only by increasing employment. International trade, however, spurs both relative labour productivity and employment at the provincial level. The long-run effect of trade on regional employment in Canada might come from two different channels. First, increased trade openness might have an effect on the regional natural rate of unemployment and participation rate. Second, trade openness might affect regional employment through the interprovincial migration channel. In the analytical framework of this paper, we are not able to separate the effect on the regional employment market through these two channels. However, given the relative substantial size of the long-run elasticities estimated here, the analysis suggests that both channels could play an important role. The asymmetric development of trade links across Canadian provinces over the last 20 years might have been

one of the driving forces behind interprovincial migration flows. Canadians tend to migrate to provinces that are developing trade links faster, and labour market conditions appear to improve with trade openness. The effect works for both interprovincial and international trade openness. Both trade channels create jobs at the regional level.

However, the effect of increased international openness on regional standards of living is different than that of interprovincial openness since it raises the level of regional labour productivity. This is one of the key results of the present analysis. Not only does international trade create jobs at the regional level, but it creates good jobs with a higher-than-average productivity level.

Finally, as shown in Tables A1 and A2 of Appendix 2, the results are robust to alternative econometric techniques for combining cross-sectional and time-series information. The results discussed above are based on the same methodology as the one used in Coulombe (2000). The approach is based on iterated feasible generalized least-squares (IFGLS) estimations using cross-sectional weight regressions. This accounts for cross-sectional heteroscedasticity and the non-parametric White heteroscedasticity-consistent standard error approach for asymptotically valid inferences in the presence of the remaining time-series heteroscedasticity. Estimation results using a seemingly unrelated regression (SUR) are presented in Appendix 1. This approach is designed to produce a feasible GLS estimator in the presence of both cross-sectional heteroscedasticity and contemporaneous correlation in the residuals. Even though the *RU* variable is not significant with SUR, the conditional-convergence model works well and the effect of the trade shares is roughly the same. The estimated long-run elasticities are close to the one estimated with IFGLS and the relative effects of interprovincial trade and international trade on per capita GDP and labour productivity are similar.

Theoretical Interpretation of the Results

The long-run relative differential effects of interprovincial and international trade on regional productivity can be interpreted in the framework of the neoclassical growth model of Solow-Cass-Koopman, coupled with the international trade model of Grossman and Helpman (1991) and Ben-David and Loewy (1998).

In the framework of the neoclassical convergence-growth equation (1), a shock to the relative y^*_i will affect the long-run relative level of labour productivity. This is what is captured by the estimated effect of international openness on labour productivity in this section. Many different theoretical channels have been developed in international trade theory to assess the effect of international trade openness on productivity. In the approach used by Grossman and Helpman (1991), for example, the level of the regional knowledge stock is positively related to the number of transactions in international markets. Trade with foreign agents creates a knowledge spillover at the regional level because it brings new ideas into the production process.

But this knowledge spillover will result from new trade links. If a group of regional economies—such as the Canadian provinces—have traded with each other for a long period of time, there is no reason to assume that there is a knowledge spillover positively related with the number of interprovincial transactions in a specific province. In a neoclassical growth framework, one can assume that the relative evolution of trade flows across Canadian provinces is in the neighbourhood of a steady-state distribution and that the knowledge associated with this trade has already been diffused among the regions. The actual relative interprovincial trade shares do not capture the rate of learning of new ideas, but rather reflect geographical locations, industrial structures, and natural resource endowments.

But such is not the case with international trade. Following the FTA with a certain lag, the positive shock on international trade might be viewed as a shock on the relative steady-state position of the provinces as the expansion of international trade since 1991 has not been distributed evenly across Canadian provinces (see Beine and Coulombe, 2003). In this framework, the central provinces of Quebec and Ontario appear to be the most favourably positioned, given their geographical location and the spectacular expansion of their international trade since 1991.

5. DISCUSSION, POLICY ISSUES, AND EXTENSION

The analysis presented in this paper suggests that, overall or from an aggregate perspective, the substantial increase in Canada-U.S. trade that followed the FTA (really starting in 1991) may have had a positive effect on the welfare of Canadians for two reasons. First, the expansion of north-south trade links did not take place at the expense of a contraction in traditional east-west pan-Canadian trade flows. Consequently, the expansion of international trade since 1991 represents new trade opportunities. Second, it appears that the increase in international trade at the regional level in Canada raises both productivity and GDP per capita in the long run. The estimated elasticities are relatively high (0.5 to 0.6 for GDP per capita and 0.3 to 0.4 for labour productivity) for international openness and consistent with estimates computed by Frankel and Romer (1999) for a cross-section of countries.

Taken together, these two results are good news for the Canadian public and policy-makers since modern growth theory is somewhat sceptical about the effect of increased trade openness and industrial specialization on the long-run economic perspectives of economies that are concentrated in primary product exports. For example, Aghion and Howitt (1998, p. 391) point out that increased international trade may not be beneficial for all types of economies. Based on the argument of dynamic comparative advantages, they fear that a natural-resource-based economy might not capture the dynamic gains of increased specialization as would economies specializing in manufacturing. Furthermore, Baldwin, Martin and Ottavio (2001) propose a growth model where increased international trade widens the gap between industrialized and less industrialized economies. In this context, despite the core-periphery nature of the Canadian economy (an industrial core located in the Quebec-Windsor corridor of Ontario and Quebec, and a vast periphery more dependent on natural resources development), our results indicate that the strong expansion of international trade links since 1991 had, on average, a positive effect on the key macroeconomic indicators of GDP per capita, labour productivity, and employment at the regional level in Canada.

We conclude with two points of prospective analysis dealing with policy issues that emerge from the foregoing analysis.

First, our empirical analysis suggests that, for the Canadian economy as a whole, the rapid expansion of international trade links witnessed since 1991 is good news since international openness has a significant impact on the long-run relative position of provinces. Recent studies on convergence across Canadian provinces (Coulombe and Day, 1999; Coulombe, 2000) indicate that since the 1980s, relative income and GDP indicators across Canadian provinces appear to be in the neighbourhood of their steady-state distribution. What remains in provincial disparities is structural and not likely to decrease following the steady convergence process observed over the 1950–80 period. The analysis presented in this paper indicates that the change in trade link orientation observed in 1991 is of such magnitude that it is likely to have already affected the long-run relative steady states at the regional level. Consequently, in a prospective analysis, we could observe a significant change in the relative evolution of some key economic indicators at the provincial level in Canada over the medium term. The precise impact of the trade shocks on the evolution of a dispersion index of GDP per capita at the provincial level is hard to predict since the relative international trade shares are still changing across Canadian provinces. Based on their evolution since 1991, one could argue that the three relative "losers" from the trade shocks are, respectively, New Brunswick, Nova Scotia and British Columbia, and that the two relative "winners" are clearly Ontario, followed by Quebec. It is important to note that the "winner" and "loser" terminology used here is relative since the estimated effect of the trade shocks on the fortunes of provincial economies is positive. But some provinces benefit more than others. The effect on the degree of regional disparity is thus difficult to predict since both rich provinces (Ontario and British Columbia) and poor provinces.

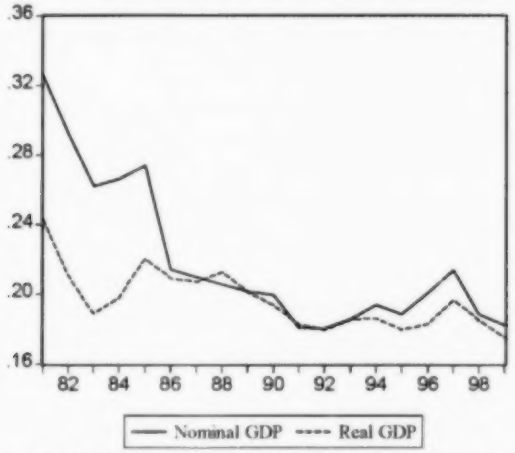
i.e., those receiving equalization payments (New Brunswick, Nova Scotia and Quebec), appear in both the winner and loser circles.

British Columbia is just starting to qualify for receiving equalization payments but it is still the third richest Canadian province. The analysis presented in this paper suggests an interpretation for the relative decline of British Columbia observed in recent years. The Pacific province has not benefited as much as the others from the rapid expansion of international trade since 1991. Geography might have played an important role here since British Columbia trade links were relatively more concentrated in Asia and its trade flows were disrupted by the Asian crisis and the poor performance of the Japanese economy.

In the growth literature, the concept of sigma-convergence is often used to describe the evolution of the mean disparity level between economies. The evolution of the relative disparity (the standard deviation of the logarithmic deviations from the provinces' sample mean) since 1981 is depicted in Figure 8 for the two per capita GDP concepts used in this paper. Sigma-convergence is defined as the tendency of the standard deviation to decrease through time. Recent studies on the convergence of Canadian provinces (Coulombe and Day, 1999; Coulombe, 2000, 2003) indicate that, since the mid-1980s, the relative dispersion of various indicators (per capita income minus government transfers, GDP per capita, human capital indicators) appears to be in the neighbourhood of their long-run steady-state level. Sigma-convergence of Canadian standard of living indicators is a phenomenon that characterized the 1950-80 period. Beta-convergence (positive and significant convergence speed such as the ones depicted in Table 3) is a necessary but not sufficient condition for sigma-convergence (Barro and Sala-I-Martin, 1995). If, initially, the dispersion level is above (or below) its long-run value, beta-convergence implies a steady decrease (or increase) in the dispersion trend toward its steady-state level. When the dispersion index is close to its steady state, sigma-convergence comes to a halt.

In Figure 8, the sharp decrease in the dispersion index of the relative nominal GDP measure observed at the beginning of the 1980s comes from terms-of-trade adjustments following the drop in the price of oil. The huge swing in the nominal GDP dispersion line is attributed to the sharp relative decrease

Figure 8
Sigma-convergence of per Capita GDP Measures



Note. Standard deviation of the logarithmic deviations from the cross-sectional sample mean.

of Alberta's position. For the overall period, the dispersion index of the real GDP measure—the one used as the dependent variable in the convergence analysis—shows a tendency to decrease extremely slowly at a rate of 0.2 percent per year. Over the 1990s, the dispersion index does not reveal any significant time trend despite the effect of changing trade patterns on the relative position of provincial economies.

Finally, there is the issue of why the interprovincial trade share displays a decreasing trend over the 1981–91 period. This is certainly a promising topic for future research. Even though the decrease in the interprovincial trade share came to a sudden halt in 1991 with the expansion of international trade, it certainly raises the question of the future of interprovincial trade. If international trade shares reach their steady-state levels in the future, will interprovincial trade shares start to decline again? The analysis presented in this paper indicates that such might well be the case for Ontario, Quebec and Newfoundland. This point raises a key policy issue regarding the future of some important institutional arrangements in the country, and more particularly the political willingness to continue to contribute to equalization payments and to maintain the current monetary regime at the regional level in Canada.

NOTES

1 A number of studies dealing with the AIT and Canadian interprovincial trade barriers can be found in C.D. Howe (1995).

2 See, for example, Frankel and Romer (1999) and Vamvakidis (2002).

3 We use trade data on goods and services in this section. The data are presented and discussed in Appendix 1.

4 In Figure 1, we follow a referee's suggestion by using the same scale for both axes. In Figures 2 to 5, we let EViews automatically select the scale axes using the 'optimized' option that shows the full variation of both series in a squared scatter.

5 See, for example, Helliwell (1998).

6 The general direction of the results (rejection of the diversion hypothesis) is not altered if the time dummy is modelled as a shock to the parameter of the *INOP* variable.

7 The results of Table 1 for the diversion hypothesis are robust to many alternative econometric set-ups. For example, following the Granger causality analysis, one could think of modelling the effect of international openness on interprovincial openness as: $ipop_{i,t} = f(ipop_{i,t}(-1), inop_{i,t}(-1), 1991break, ...)$. In this dynamic set-up, using correction for serial correlation and IFGLS estimation, the point estimate for the lagged international openness variable is positive and significant at the 1 percent level.

8 The percentage change is measured as a logarithmic difference.

9 Vamvakidis (2002) provides a short updated synthesis of the vast and growing empirical literature on the growth-openness connection.

10 See, for example, the discussion on this topic in Temple (1999).

11 We have to switch to the 1981-99 sample since real GDP data are not available for 2000.

12 The results are robust to specific modelling of Alberta and Quebec dummy variables. The Alberta fixed effect is generally positive and significant, while the Quebec fixed effect is negative and significant.

13 If γ_1 equals one, there is no steady-state growth path.

14 See the data appendix for a discussion of the two concepts of relative trade measures.

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APPENDIX 1:
A NOTE ON DATA

The appropriate choice of data is critical for the empirical analysis developed in this paper. It is important to point out that two sets of provincial GDP and trade data are used here. The first set is the nominal GDP data from the Gross Domestic Product, Expenditure-Based matrices (CANSIM Matrix 9023 for Alberta and subsequent numbers for the other provinces). The second set is real GDP data deflated with provincial GDP deflators taken from the Gross Domestic Product at 1992 Prices matrices (CANSIM Matrix 9037 for Alberta and subsequent numbers for the other provinces).

In the econometric and descriptive analysis, the trade shares are measured as the ratio to GDP (Section 2) or the logarithmic deviations from the cross-sectional mean (Section 3). Consequently, all variables are expressed in real terms, whether they come from the nominal or the real data bases. The difference between the two sets of variables is intrinsically related to regional terms of trade and to the specific composition of regional GDP. With the set of GDP and trade data computed from the nominal data base, deviations from cross-sectional means and ratio of trade to GDP include variations in terms of trade; however, these variations are excluded from the variables computed with the real data set.

A good example to illustrate this difference is the effect of an oil shock on Alberta. An increase in the relative price of oil will expand the output and export measures of Alberta in the nominal GDP data set because the relative value of oil produced in Alberta and exported abroad increases. This regional terms-of-trade effect will be eliminated from the data set based on real GDP as only real flows (volume of oil) are computed in this data base. Consequently, if one wants to use a real regional relative GDP measure that is intrinsically related to the real regional relative income (and welfare), one has to use relative values computed from the nominal GDP data set. An increase in the price of oil raises real relative income and relative trade values for Alberta even though there is no increase in oil production.

The two sets of data produced useful information and both have been employed. When we estimate the long-run effect of a trade shock (in Section 3) on relative per capita GDP, the regional GDP has to be measured from the real GDP data set. This is necessary to purge the dependent variable (real income) from exogenous shifts in terms of trade determined on international markets. However, if one is interested in measuring the relative evolution of trade links between regional economies, the nominal data set is the appropriate one; it captures the change in the relative value of trade across the regional economies. Another example will illustrate this point. If the United States exported ten times more computers to Canada in 2000 than in 1990 at one-tenth the price, measuring the growth of U.S. trade in Canada from a nominal GDP data set will show that U.S. exports to Canada have multiplied by 10 over the period. However, using a real GDP data set, the real relative value of computer exports to Canada has not increased during the period. This is why the relative trade data used to illustrate the 'L' curve in Section 2 and in the econometric analysis presented in that section are computed from the nominal GDP data set and include the evolution of terms of trade.

Only the real data set (based on provincial GDP deflators) was used to compute the GDP per capita and labour productivity series employed as dependent variables in the convergence regressions of Section 3. Both sets of data were used to compute alternative measures of international and interprovincial trade shares in the convergence regressions of Section 3 (nominal versus real in Tables 3 and 4). The analysis of Section 2 focuses on the data set generated from the nominal GDP measures. The evolution of the ratio of exports plus imports to GDP then includes the evolution of terms of trade.

The employment data used to compute labour productivity from the real GDP data set correspond to total employment (CANSIM Matrix 9228 for Alberta and subsequent numbers for the other provinces).

The urbanization variable of Section 4 is borrowed from Coulombe (2000) and refers to the percentage of the population living within census metropolitan areas and census agglomerations over 10,000 inhabitants. The original data were computed from the population censuses by Ray Bollman of Statistics Canada.

APPENDIX 2:
ESTIMATION OF EQUATION (2) WITH SUR

Table A1
Estimation Results for per Capita Real GDP and Real Labour Productivity Convergence Regression with SUR

Dependent Variable $Y \Rightarrow$	Real GDP per Capita (1)	Real GDP per Capita (2)	Real Labour Productivity (3)	Real Labour Productivity (4)
y (-1)	0.973***	0.984***	0.953***	0.959***
	(0.014)	(0.015)	(0.024)	(0.024)
RU	0.007	-0.005	-6.39E-05	-0.001
	(0.012)	(0.012)	(0.006)	(0.006)
INOP (-1) (nominal)	0.019***		0.014***	
	(0.006)		(0.005)	
IPOP (-1) (nominal)	0.013**		0.001	
	(0.005)		(0.003)	
INOP (-1) (real)		0.010**		0.012**
		(0.006)		(0.005)
IPOP (-1) (real)		0.005		0.001
		(0.004)		(0.003)
S.E. of regression	0.023	0.024	0.021	0.021
R-squared	0.984	0.984	0.959	0.959

Notes: SUR is seemingly unrelated regression.
***, ** and * indicate that the null hypothesis could be rejected at the 1 percent, 5 percent and 10 percent critical levels, respectively.
Adjusted sample 1982–99; 180 panel observations.
Estimations were done using EViews 4.0.

Table A2
Long-run Elasticity of Environmental Variables

Dependent Variable $Y \Rightarrow$	Real GDP per Capita	Real Labour Productivity
INOP (nominal)	0.47	0.31
IPOP (nominal)	0.69	–
INOP (real)	0.65	0.29

Note: Computed from Table A1 using the long-run solution of equation (2). No significant effect for *IPOP* nominal.

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